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Full Length Research

Response of Phosphorus fertilizer rate on Growth, Yield and Yield Components of Onion (*Allium cepa* L.) at East Gojjam Zone, North Western Ethiopia

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A field experiment was under taken to study the effect of different levels of phosphorous on growth and yield of onion (Alluim cepa L.) var. Adama red in Northwestern Ethiopia, Debre Markos university during 2015 under irrigation condition. Onion is the most essential vegetable for nutritional and economical purpose. But there was low yield: under farmer's field between 9 to 15 t ha^{-1} which was far less than research sites which was 30 to 35 t ha^{-1}. Therefore, four rates of phosphorous (0, 60, 90 and 120 kg ha^{-1}) were arranged in a Randomized Complete Block Design (RCBD) and replicated three times. The total plot size was 3.7m by 4.8m (17.76m^2) and the net plot was 0.9m X 0.9m (0.81m^2). Phosphorous showed significant difference on yield parameter of onion. Plant height had significant difference at four levels of Phosphorous. Maximum leaf diameter and number of root were observed at 90 kg and 120 kg of phosphorous than control and 60 kg of phosphorous; But no significant difference on leaf number from growth parameter. Maximum bulb diameter, fresh bulb weight and dry bulb weight was recorded at 60, 90 and 120kg ha^{-1} than control. But vertical bulb thickness had non-significant difference on each phosphorous levels. By considering cost of production 60kg P ha^{-1} level was recommended from all significant difference Parameters.

Key words: Bulb Diameter, bulb weight, phosphorous

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INTRODUCTION

Onions (Allium cepa L.) are biennial herbaceous members of the family Alliaceae that are typically grown as annuals. It belongs to the genus Allium which contains 300 species which widely distributed in northern temperate region. They are native to southern Asia and Ural Mountains and have long been valued in china and India for their flavorings (Henelt, 1990).

Globally, onion is produced at nearly 35 million tons per annum (FAO, 2005). In Ethiopia onion is widely grown in the rift valley and lakes region of the country (Lemma and Shimeles, 2003). The total area under onion in Ethiopia was estimated to be 15628.4 ha with total production of (0.148 Mt), in the year 2008 with an average of 7.9t/ha (CSA, 2009).

Onions are cool season crop adapted to wide range of temperature and can withstand short exposure to temperature well below freezing. Optimal production is obtained when cool temperatures (55 to 77 ^{o}F). They are

gown on much too heavy clays. Onion plants is sensitive to high acidity and produces maximum yield over fairly narrow ranges of soil reaction on sandy loam soil on long island reported that maximum of onion produced at PH 5.8-6.5 (Halliburton, 1996).

Onion is one of the most important condiments, being widely used in green form or as mature bulb or both salad and for preparation of a number of dishes like soups, sauces and for seasoning of foods Mild flavored or colorful bulb onions are often chosen for salads (Khan et al, 2005). Varieties with high total soluble solutes (TSS) content are convenient for processing in the form of dehydrated slices. Consumer often has very strong local preferences for size, shape and pungency bulb of onion (Curran and Proctor, 1990).

The productivity of onion atfarmer's field ranges between 9 and 15 t/ha which is far less than the yield obtained under research area which is 30-35 t/ha (Lemma and Shimmeles, 2003). These can be due to many factors. The most important factors are lack of optimum levels of phosphorus fertilizers (Abdisa et al, 2011).

Phosphorus fertilizer is one the most complex in production in many tropical soils, owing to low native content and high phosphorus immobilization with in the soil. Phosphorus is essential for root development when availability is limited, plant growth is usually reduced. In onion, phosphorus deficiencies reduced root and leaf growth, bulb size and yield and also delay maturation (Abdisa et al, 2011).

In the soils that are moderately low in phosphorus, onion growth and yield can be enhanced by applying phosphorus. Onions are more susceptible to nutrient deficiencies than most crop plants because of their shallow and un branched root system, hence they require and often respond well to addition of fertilizer (Brewester, 1994).

Onion is grown in most parts of Ethiopia but, a lot of constraints have contributed to the low yield. Phosphorus deficiency is one of the constraints to onion production in many tropical soils. The use of sub optimal phosphorus fertilizer is one of the prominent to mention. Still well recommendation rate of phosphorus fertilizer is not well identified. So farmers get low yield and poor quality of onion. Therefore, this research was initiated to determine the effect of phosphorus fertilizer on the growth and yield of onion at east gojjam zone.

MATERIAL AND METHODS

Experimental Location

The study was conducted in Debre Markos University in the year 2015/16. Debre Markos is the capital of East Gojjam Administrative Zone is located in the northwest of capital city of Ethiopia; Addis Ababa at a distance of 300 Km and 265 Km to the capital of Amhara Nation Regional State Bahir Dar. The Geographical location of the study area is located between 10°17′00″ to 10°21′30″ N Latitudes and 37°42′00″ to 37°45′30″ E longitudes and its elevation ranges in altitude from 2350-2500 meters above sea level. The town has 1380 mm average annual rainfall and minimum and maximum temperatures of 15 ^{0}C and 22^{0}C, respectively.

Experimental Design and Treatment

The treatment used consists of four levels of phosphorous (0, 60, 90,120kg P_2O_5/ha) arranged in randomized complete block design (RCBD) with three replications; 15cm spacing were kept between rows and plants. Each plot had an area of 0.81m^2 (0.9m length and 0.9m width) and the spacing between block is 0.5 m and spacing between plot is 0.4m. The total area covered by the plots is 17.76m^2.

Experimental Procedure

The experimental field with flat slope was selected and cleaned. The field (experimental area) was tilled three times, pulverized and softened by application of water. The land layout was taken and measured accurately by using Pythagoras theorem in the rectangular form with the total area of 17.76m^2. The land was divided into twelve plots which had four treatments and three replications. Phosphorus fertilizers were incorporated to soil during the onion seedling planted. Watering and other cultural practices were conducted according to their recommendation. Other cultural practice like weeding, cultivating and fertilizing were carried out properly.

Data Collection

Data collections on growth parameters (plant height, number of root per plant, number of leaf per plant and diameter of leaf plants) were taken at vegetative growth except number of roots per plant that was taken at harvesting time. Quality and yield parameters at harvesting time of bulb were also collected on (diameter of bulb, vertical bulb thickness) and (fresh bulb weight, dry bulb weight) respectively.

Statistical Analysis

All data collected were subjected to analysis of variance by statistical procedures as described by Gomez (1984) and means were compared using least significance difference (LSD) at 5% probability level and SAS version 9.1 was used for the analysis

RESULTS

Growth parameters

The growth of onion was influenced by different levels of phosphorus fertilizer. After data analysis the result of the study indicated that phosphorus has significant effect on some growth parameters (plant height, leaf diameter and root number) and had non-significant effect on other growth parameters (number of leaf). This is indicated in (Table 1).

Quality Parameters

Quality of onion was influenced by applying different doses of phosphorus fertilizer. Phosphorus fertilizer have significant difference on diameter of bulb and have no significant difference on vertical thickness of bulb. This can be indicated (Table 2).

Yield Parameters

Yield of onion was influenced by applying different doses of phosphorus fertilizer and someyield parameters exhibited significant difference (fresh bulb weight and dry bulb weight).

DISCUSSION

Growth parameters

Plant Height

The result from (Table 1) revealed that different phosphorus fertilizer levels significantly affect plant height. Maximum plant height (54.90cm, 50.86cm, 46.26cm and 41.20cm) was noted in plots applied with phosphorus at the rate of (120, 90, 60 and 0 P_2O_5kg ha^{-1}) respectively. Based on the result of the levels of phosphorous (120, 90, 60 and 0kg P_2o_5 /ha), there was significant difference observed, plant height showed an increase with increasing levels of phosphorus fertilizer. This could be due to the fact that phosphorus is essential component of the energy transfer components (ATP and other nucleic proteins, genetic information system and cell membranes that result to rapid plant growth (Bsawas and Mukherge, 1993).

Number of Leaf

As can be observed from (Table 1), the result showed that there is non-significant (P>0.05) difference between different phosphorus levels (0, 60, 90 and 120 kg P_2O_5 ha^{-1}) on onion with respect to number of leaf at 5% probability level.

Diameter of Leaf

As observed from data analyzed in (Table1), the result showed that there were significance difference among different phosphorus nutrition rate. Maximum leaf diameter (16.20 and 16.36) was observed in plots treated by phosphorus at the rate of 120 and 90 kg P_2O_5 ha^{-1} respectively. But, minimum diameter of leaf (12.90mm and 8.30mm) was observed in 60 kg P_2O_5 and control respectively. The reason could be, phosphorus encourages plant growth, because phosphorus is an essential element. Particularly, phosphorus is a major building block of DNA molecules (Vechhani and Patel, 1996 and Morgan et al, 2005).

Number of Root per Plant

From the results reviewed in (Table1), it was evident that different phosphorus fertilizer levels have significant difference on number of roots per plant of onion. The result recorded indicated that different levels of phosphorus fertilizer rate (120 and 90 P_2O_5 kg ha^{-1}) with 132.66 and 126 respectively have significant difference on number of roots per plant of onion at 5% probability level than minimum number of root of (113) and (72.33) was observed in 60 kg P_2O_5 and control respectively. The reason is that addition of phosphorus fertilizer insures that crops will reach their full potential by using additional phosphorous, to encourage root growth and promoting resistances to root diseases (Brady and Weil, 2002)

Quality Parameter

Bulb Diameter

The result of study revealed that a different level of phosphorus fertilizer (120, 90, and 60 P_2O_5kg ha-1) with 45, 42.80, and 44.33mm respectively has significant difference on bulb diameter of onion (Table 2), at 5% probability level. Minimum bulb diameter of (30.86mm) was observed in the control (no phosphorous). These are due to that increasing phosphorus application increased bulb weight and size (Vechhani and Patel, 1993).

Vertical Bulb Thickness

According to the results regard on quality of onion in (Table 2), different phosphorus fertilizer levels had non-significant (P>0.05) effect on vertical bulb thickness of onion. Interpretation result indicated that four levels of phosphorus (120, 90, 60 and 0 kg P_2O_5) have no significant difference at 5% probability level. Even though statically no significantly difference, there are some differences among mean separation of each four treatments. But the vertical bulb thickness was increased at the three levels of phosphorus fertilizer than control.

Table 1. Effect of different levels of phosphorus fertilizer on height of plant, number of leaf, diameter of leaf and number of root.

Treatments	Plantheight (cm)	Number of leaf	Leaf diameter(mm)	Number of root
120kg P_2O_5/ha	54.90[a]	13.667[a]	16.20[a]	132.66[a]
90 kg P_2O_5/ha	50.86[b]	22.333 [a]	16.36[a]	126.00[a]
60 kg P_2O_5/ha	46.26[c]	27.333 [a]	12.90[b]	113.00[b]
Control	41.20[d]	9.667 [a]	8.30[c]	72.33[c]
LSD	3.66	21.62	2.94	10.29
Significance level	***	NS	**	***
CV (%)	3.789	29.297	10.948	4.64

Means followed by the same letter are not statistically significant different at α =5%.
NS: non-significant, **CV**: coefficient of variance and **LSD**: least significant difference at α=5%. *** indicate significance at 0.001probability level,** indicate significance at 0.01probability level

Table 2. Effects of different levels phosphorus fertilizer on quality of onion.

Treatments	Bulb diameter(mm)	Vertical bulb thickness(mm)
120kg P_2O_5/ha	45.00[a]	37.13[a]
90 kg P_2O_5/ha	42.80 [a]	36.56[a]
60 kg P_2O_5/ha	44.33 [a]	37.76[a]
Control	30.86[b]	30.53[a]
LSD	5.34	11.18
Significance level	**	Ns
CV (%)	6.55	15.77

Means followed by the same letter are not statistically significant different at α =5%.
NS: non-significant, **CV**: coefficient of variance and **LSD**: least significant difference at α=5%. ** indicate significance at 0.01probability level

Table 3. Effects of different levels phosphorus fertilizer on yield of onion.

Phosphorus (kg ha^{-1})	Fresh bulb weight(g)	Dry bulb weight(g)
120	38.16[a]	10.00[a]
90	33.33[a]	9.167[a]
60	38.30[a]	11.30[a]
0	17.43[b]	5.000[b]
LSD (5%)	11.44	3.91
Significance level	**	**
CV (%)	18.011	22.107

Means followed by the same letter are not statistically significant different at α =5%.
Ns: non significant, **CV**: coefficient of variance and **LSD**: least significant difference at α=5%. ** indicate significance at 0.01probability level

The reason is according to Shaheen et al, (2007) revealed that phosphorus on indispensable role in energy metabolism, the high energy hydrolysis phosphate and various organic phosphate bonds being used to induce chemical reaction Phosphorus is essential for process of photosynthesis and maturation which result to vertical bulb thickness (Brady and Weil 2002).

Yield Parameters

Fresh Bulb Weight

Data analysis from (Table 3) above indicated that phosphorous fertilizer levels had significant effect on fresh bulb weight of onion. Maximum fresh bulb weight was recorded in the plots applied phosphorous fertilizer levels at (120, 90 and 60kg $P_2O_5ha^{-1}$ than controlled or zero P_2O_5 ha^{-1}) which was (38.16, 33.33, 38.3 and17.43g) in mean weight respectively. Fairhust et al,

(1999) states that phosphorous was essential for root growth which results to absorption of water and other nutrient which in turn results to increase in fresh bulb weight.

Dry Bulb Weight

From the analyzed of data in (Table 3), it was clearly observed that different levels of phosphorous have significant difference on dry bulb weight. Maximum dry bulb weight was obtained when the fertilizer was applied at the rate of 120, 90 and 60kg P_2O_5 ha^{-1} than controlled one. This is difference due to the reason that; Application of phosphorus level positively increases and significantly affects bulb length, bulb diameter, average bulb weight, bulb dry matter content, marketable yield and total bulb yield (Aster, 2009). Therefore, phosphorous fertilizer at the rates of 120, 90 and 60kgha^{-1} can increase dry bulb weight in the mean bulb of (10.00, 9.16 and 11.30g) than controlled one which is 5.00g.

SUMMARY AND CONCLUSION

Generally, onion (Allium cepa. L) var. Adama red is one of the main cool season vegetable crops that largely grown for different purposes like daily human diet, as salads and for preparation of various dishes like soups, sauces and seasoning of food. The productions of onion vary from year to year and become decreasing. In farmer's field it ranges between 9-15 t/ha which was much less than the yield obtained under research which was 30-35 t/ha (Lemma and Shimeles, 2003). The main problem for these is that lack optimum level fertilizer mainly phosphorus fertilizer.

The recommended rates of phosphorous vary from area to other area based on the soil condition of the locality and there is no worldwide accepted rate of phosphorous for onion (FAO, 2008). Still well recommendation rate of phosphorus fertilizer is not well identified. To this purpose this research initiated to determine appropriate rate of phosphorous on the growth performance and yield of onion.

Phosphorus at levels of (control, 60, 90 and 120 kg /ha) was used with three replications. Data was collected from each treatment, the result indicated that phosphorus fertilizer had significant difference on growth of onion like, number of root, leaf diameter and plant height. Table 1 stated that the maximum number of root, leaf diameter and plant height was obtained at (120,90 and 60 kg /haP_2O_5) level than controlled (0 kg /haP_2O_5).

From quality parameter it was observed that there was non significance ($P>0.05$) difference among phosphorus fertilized on vertical bulb thickness. Phosphorus fertilizer had significance difference on diameter of bulb was obtained at (120, 90 and 60 kg /haP_2O_5) than controlled level.

Data analysis indicated that phosphorus fertilizer had significance difference on yield parameters. Maximum fresh bulb weight (38.30 g) and dry bulb weight (11.30 g) was obtained at 60 kg /haP2O_5 than other P_2O_5 levels. By considering cost of production at 60 kg /haP_2O_5 level was recommended on growth and yield of onion. moreover, further research in different agro ecologies should be done for further precision

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